GLOBAL REACH AND
AIR CARGO OPERATIONS:
A STUDY IN
MATERIALS HANDLING EQUIPMENT (MHE)
REQUIREMENTS

Graduate Research Paper

Keith E. Nickles, Captain, USAF

AFIT/GMO/LAL/96J-7

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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GRADUATE RESEARCH PAPER

Presented to the Faculty of the Graduate School of Logistics and Acquistion Management

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Masters of Air Mobility

Keith E. Nickles, B.A., M.A.S.

Captain, USAF

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Keith E. Nickles

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Abstract

This research paper examines airlift system support issues, and in particular, issues concerning Materials Handling Equipment (MHE). Limitations of existing loaders have forced AMC to adopt the practice of using airlift to reposition MHE between theater locations. Such a practice is costly to the command, both in terms of monetary expense and capability. Two issues relating to MHE will be examined in this paper: the cost of repositioning these assets and the impact of repositioning on force closure.

To meet system demands, AMC commits a significant amount of airlift to repositioning MHE. This practice is costly in terms of time and money. Lost time in a two MRC scenario can be the difference between success or failure. This study suggests that in a contingency environment, transporting MHE between locations causes significant delays in force closure estimates. Operational experience has demonstrated that AMC will have difficulty meeting a two MRC airlift requirement using existing loaders, which seriously jeopardizes our ability to project power abroad. Modernizing the MHE fleet is key to meeting the requirements of a two MRC strategy.

GLOBAL REACH AND AIR CARGO OPERATIONS:

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I. Introduction

General Issue

Strategic mobility has evolved from an afterthought in contingency planning to the linchpin of a successful military operation. However, the progressive erosion of airlift capability will make it more difficult to support the warfighting Theater Commander-In-Chief (CINC), and indications are Air Mobility Command (AMC) will have limited airlift assets available to meet future requirements. The rapidly approaching retirement of the C-141 Starlifter, combined with an aging C-5 fleet, marks the arrival of another challenge to our ability to execute the strategic airlift mission.

The demise of the Soviet Union has changed the way the United States prepares for potential conflict. Current National Military Strategy (NMS) is structured to support two nearly simultaneous Major Regional Conflicts (MRC) (Clinton, 1995:19). This strategy, developed by former Secretary of Defense Les Aspin and inherited by his successor William Perry, is heavily dependent on enhancing certain aspects of our strategic mobility capability (Pine, 1994:6). Modernizing the strategic air mobility fleet was United States Transportation Command's (USTRANSCOM) number one equipment priority for 1995, and fortunately for AMC the Pentagon authorized the purchase of 120 C-17s, solidifying that aircraft's future as the next core strategic airlifter (Rutherford, 1995:5).

While buying more C-17s is the most visible and costly airlift enhancement, it is by no means the only one important to AMC. To meet the two MRC strategy, the Mobility Requirements Study (MRS) identified an airlift requirement that ranged from 49.4 Million Ton Miles/Day (MTM/D) to 51.8 MTM/D (MRS, 1995:ES-6). Before that level of airlift can be achieved, AMC will need to make improvements in the support equipment that forms the backbone of the strategic airlift system. Using a moderate risk assessment, the MRS analyzed the two MRC strategy and identified the mobility force requirements needed to support the following warfighting phases: halting, buildup, and counterattack (MRS BURU, 1995:ES-2). The halting phase relies on the ability to rapidly stop an aggressor's attack. Since contingency operations seldom come with ample advance notice, this phase would rely almost exclusively on airlift and prepositioning. To meet this requirement, AMC must have an airlift system that is capable of rapidly deploying combat forces to the theater. The key word is rapid, but before those combat forces can be moved AMC must first have the support equipment in place to accept them.

One such type of support equipment is Materials Handling Equipment (MHE). See Appendix B for a description of MHE. Current levels of mission capable 40K, 25K, and Wide Body Elevator Loaders (WBEL), both in the Continental United States

(CONUS) and overseas, are below authorization levels (Wingreen, 1995). Years of underfunding of MHE have forced AMC to adopt some inefficient logistics practices. To meet operational demand, AMC must often reposition available MHE from one theater to another. This practice creates a tremendous drain on available airlift capacity by potentially displacing critical combat troops and equipment (AMMP, 1995:4-62). With the retirement of the C-141 less than 10 years away, and given the enormous airlift requirement of MHE, it is readily apparent AMC will commit a significant amount of airlift to deploy support equipment to the theater. This shortage of dependable MHE threatens to cripple America's ability to rapidly project combat forces to trouble spots around the world.

Shrinking defense budgets make it increasingly important to make wise equipment acquisition decisions. In addition, once a piece of equipment is purchased, the user must make good logistics decisions regarding its location. Specifically, should MHE be kept it in the CONUS, or be forward deployed? In the airlift business, where MHE is positioned directly affects our ability to project combat forces. Since MHE plays such an important role in our airlift operations, how it is managed warrants increased attention.

As American overseas presence recedes, our military forces become more dependent on strategic mobility (Aspin, 1993:8). The ability to project military force to crisis spots around the world is a capability that is exclusively American. Contingency Operations in Somalia, Rwanda, and the Middle East have highlighted that fact. The constant reliance on airlift has accelerated the retirement of AMC's core airlifter and adversely affected the service life of MHE. In short, the strategic airlift system is in bad shape. While the present situation certainly did not develop overnight, it has only recently received increased attention. The country needs a strategically responsive force more than ever, but the military will always be limited in the number of assets it can acquire. The only way to meet the increasing demand for strategic airlift is to make the most of available assets. In other words, AMC must plan and fight smarter. The acquisition of 120 C-17s and the 60K loader is a major improvement over current systems, but that is only part of the responsiveness equation. The rest must be achieved through other means.

Problem Statement

The greatest problem with MHE is that there are simply not enough reliable loaders available to fulfill the requirements of AMC's enroute locations, which results in using a significant amount of airlift just to get this equipment to the theater. For years, the Air Force did not consider MHE availability and support problems to be serious enough to warrant increased funding. In fact, the new 60K loader is the first replacement loader acquired in the 34 year history of the 463L pallet system (Coker, 1994). Of course, previous funding was driven by a different set of priorities, and at that time the U.S. had a significant overseas presence that provided much of the needed support equipment (Blackwell, 1991:35). Today, AMC often moves support equipment from one location to another in order to meet aerial port requirements. Such repositioning of assets has a significant monetary cost associated with it, both in peacetime and war. Perhaps equally important is the cost associated with delaying force closure, or the amount of time it takes to deploy combat forces to the theater (Wingreen, 1995). Today, the number of forward deployed troops and equipment is a fraction of the amount maintained during the Cold War. This reduction has exposed some potentially serious problems in our ability to project combat forces worldwide.

The focus of this paper will be toward comparing the monetary cost of acquiring and prepositioning additional MHE to the cost of using organic airlift to move MHE from one theater to another.

Need for Resolution

Years of neglecting our strategic mobility capability has forced AMC to use critical airlift to bring mission capable MHE to the theater. Prepositioning these assets at strategic enroute locations would allow us to make more efficient use of available airlift. Prepositioning directly affects the speed that AMC is able to transport warfighting forces to the theater, because often support equipment must move ahead of combat forces. American military operations rely heavily on long range mobility, with most of the personnel and equipment coming from the CONUS. In short, strategic mobility is the foundation upon which current American military strategy is built, and the ability to execute this mission effectively is at the heart of our National Security Strategy (Clinton, 1995:29).

Investigative Questions

The following questions will form the basis of my investigation into MHE:

1. Do current MHE levels meet today's mobility requirements?
2. How much does it cost to airlift a 40K loader from a CONUS location to an enroute location in a peacetime scenario?
3. What effect does using airlift to reposition MHE have on force closure?
4. What is the cost of purchasing additional loaders to bring AMC units up to their authorization levels?

Summary

The question of MHE availability, supportability, and prepositioning has serious implications for AMC's ability to meet America's global reach requirements. Currently, AMC possesses a fleet of MHE that is frequently moved from one location to another just to meet enroute support requirements. The monetary cost alone of using organic airlift to move support equipment is sizable, but equally important is the cost associated with delaying force closure. Both of these costs directly affect AMC's ability to respond to a national emergency. Given the finite budget that AMC has at its disposal, it is imperative that the command structure its airlift system in such a way as to get maximum capability from limited resources. In that light, exploring the options available for more effectively managing MHE is the focus of this paper.

II. The Issues Surrounding MHE

Introduction

Since the collapse of the Berlin Wall the number of potential worldwide crisis points has doubled to nearly 70 (Rutherford, 1995:2). Some of those potential crisis points have gone on to challenge our national security interests. Operations in Haiti and the former Yugoslavia are but two of the most recent events that have severely tested our Defense Transportation System (DTS), and each clearly illustrates how much our national security strategy depends on strategic mobility:

> In this new era, the ability to project our power will underpin our strategy more than ever. We must be able to deploy substantial forces and sustain them in parts of the world where prepositioning of equipment will not always be feasible, where adequate bases may not be available and where there is a less developed industrial base and infrastructure to support our forces once they have arrived...we must sustain and expand our investment in airlift, sealift and prepositioning. (National Security Strategy, 1991:28)

With greater frequency, the United States military finds itself preparing for not only combat missions, but also for Military Operations Other Than War (MOOTW). Such operations will likely keep America's already exhausted transportation forces busy well into the next century. The only way to guarantee success in future contingencies is to maintain a DTS that is efficient, dependable, and flexible. Unfortunately, the deterioration of most of AMC's cargo loaders has adversely affected the efficiency and dependability of the airlift system. Table 1 lists the current status of MHE.

Table 1.
Materials Handling Equipment Status (Wingreen, 1995).

Vehicle Type	Percent Assigned[1]	Average Age	Design Service Life[2]
40K	68/78	22 yrs	8 yrs
25K	75/95	22 yrs	10 yrs
WBEL	51/49	11 yrs	10 yrs

[1] Assigned as a percentage of authorizations for 1994 and 1995 respectively.
[2] Life expectancy when purchased, not remanufactured life.

On the surface, the figures shown in Table 1 represent a net increase from the previous year in the number of authorizations for both the 40K and 25K loaders, while the WBEL showed a slight decrease. Taken by itself, these figures can be misleading. The authorization values for each loader have been generated using the airlift requirements identified in the MRS (Wingreen, 1996). Based on that fact, it is clearly evident that the 40K and WBEL are well below the levels needed to adequately meet the air mobility requirements in a two MRC scenario. This seriously questions the validity of the two MRC strategy altogether, and will undoubtedly make AMC's job more complicated.

Fortunately, the overall outlook for MHE is improving, but much of that optimism can be attributed to the planned acquisition of the 60K loader, which is still several years from being fully fielded (Rutherford, 1995:7). The most telling information can be gathered by looking at the average age of available MHE. With the exception of the Wide Body Elevator Loader (WBEL), the 40K and 25K loaders have long exceeded their designed life expectancy. That fact, combined with sustained heavy use, equates to an MHE fleet that is prone to failure. The current condition of MHE creates tremendous planning and execution difficulties for USTRANSCOM.

USTRANSCOM's Dilemma

United States Transportation Command is the sole provider of common user strategic transportation for the DOD. During crisis or war, USTRANSCOM is responsible for planning, directing, and coordinating the global air, land, and sea transportation of U.S. forces in response to national security needs (DOD, 1993:E-4). The task of matching the transportation requirements of the various services with the assets available in the DTS is monumental, and to perform the execution function, TRANSCOM relies on three component commands: Air Mobility Command (AMC), Military Sealift Command (MSC), and Military Traffic Management Command (MTMC). As shown in Figure 1, the complementary capabilities of these three component commands form the "mobility triad"—airlift, sealift, and prepositioning (Rauhecker, 1992:3).

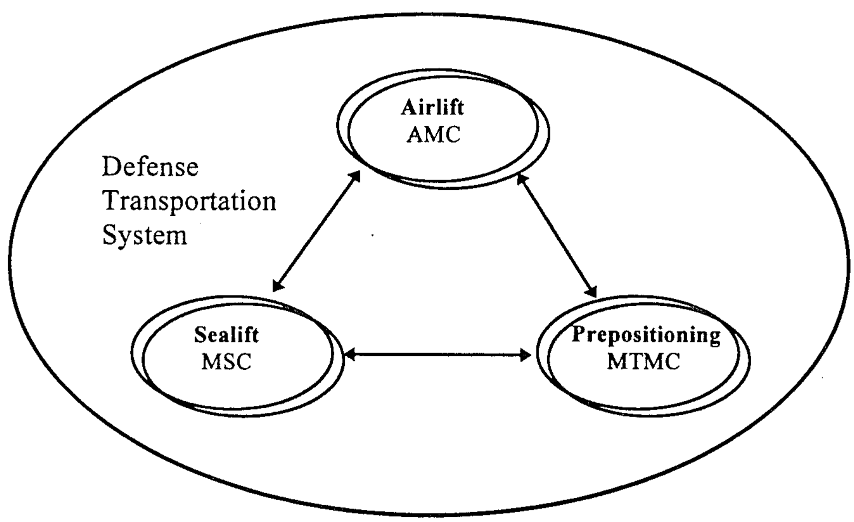

Figure 1. The Mobility Triad (Miller,1988:428)

Each of these elements plays a vital role in America's national security strategy, but only airlift combines the decisive advantages of speed and flexibility. These two characteristics are cornerstones of the two MRC strategy (MRS BURU, 1995:ES-1). However, during a large scale deployment, airlift will account for only a very small percentage of the total cargo transported. Ships will handle the vast majority of deploying equipment (Menarchik, 1993:167).

Airlift is best suited for the transport of high value, time-critical equipment and personnel. Given the limited number of available airlifters and the competing interests of the other services, TRANSCOM uses a system of priorities identified by the Joint Staff, as well as guidance from the supported theater commander, to determine what assets are the most critical (DOD, 1993:E-2). Materials Handling Equipment is an example of one such type of equipment. As mentioned earlier, the second conflict in a two MRC strategy is highly dependent on airlift to transport forces from one region to another. However, before the airlift system can achieve full capacity, MHE must arrive ahead of the main airlift flow, otherwise the air movement of supplies and personnel would come to a grinding halt. Figure 2 shows both the additive and individual affect of MHE delays on cargo operations during Operation Desert Shield. Such delays created difficulties for command and control agencies as well as supported units, because of an inability to accurately project arrival times.

These numbers may seem insignificant for an operation of that size, but they are misleading, because they do not illustrated the impact that such delays had on the airlift system as a whole (Lund, 1993:46). In fact, MHE problems did slow the airlift flow by restricting the number of aircraft that could be effectively handled at a particular base at a given time. Any delay at an offload location, regardless of length, creates a ripple effect that works its way through the entire air mobility system. According to CINCTRANS, "An airlift system is only as good as the materials handling equipment supporting it," (Rutherford, 1995) and any delay in cargo downloading operations can directly affect our ability to halt a potential aggressor. The expected urgency of a transition from one MRC to another would be further aggravated if the airlift flow bogs down at key theater aerial ports.

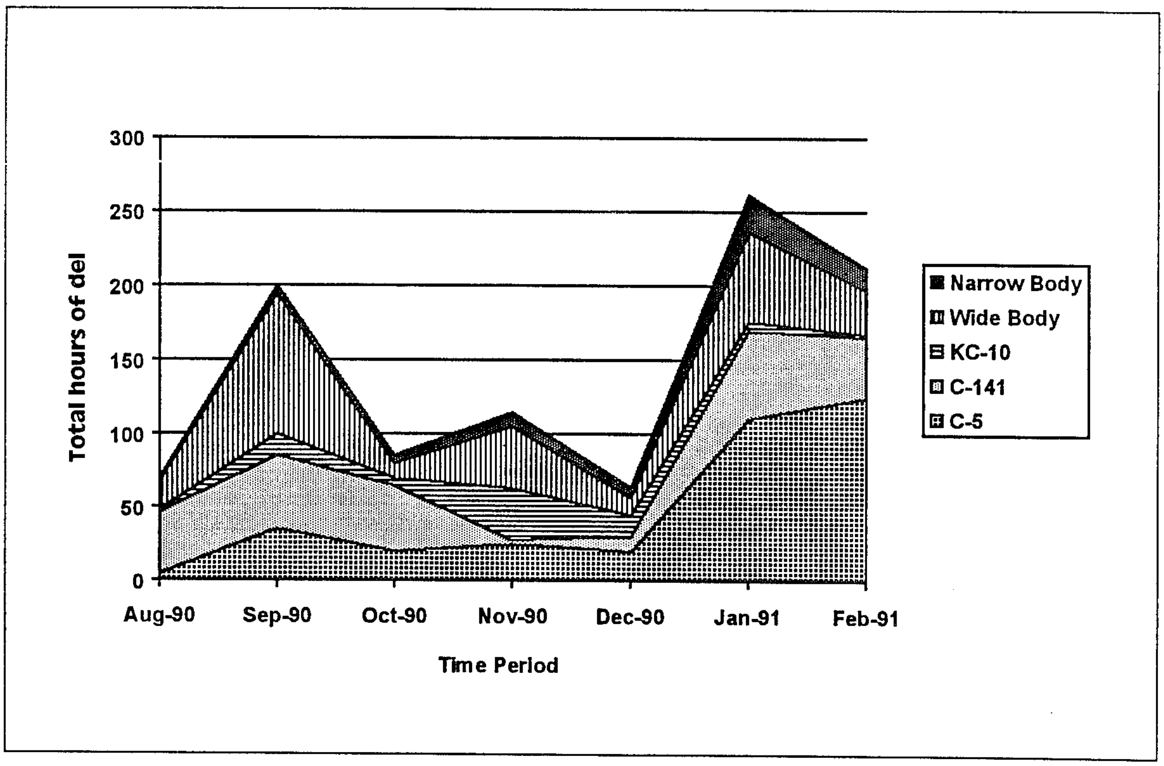

Figure 2. Total Mission Delays for MHE - Operation Desert Shield (Lund,1993:46)

The Importance of Strategic Prepositioning

Air Mobility Command acts as the office of primary responsibility (OPR) for the vast majority of MHE within the DOD (AFI 25-101,1995:5). The fragile status of our MHE fleet requires constant attention. Currently, AMC has 1,350 40K, 25K, or WBELs located at 242 different locations worldwide. Appendix C lists the worldwide location, type, and quantity of MHE managed by AMC (Wingreen, 1995). Including available War Reserve Material (WRM), the present MHE inventory fills only 77 percent of planned DOD requirements (Rutherford, 1995:5). To meet both peace and wartime requirements, AMC relies heavily on prepositioned MHE. As shown in Table 2, shortfalls in WRM are significant. At current levels, AMC has no choice but to use critical airlift capacity to reposition available aerial port assets from one theater to another. Materials Handling Equipment is such an integral part of AMC's Global Reach mission that acquisition of the 60K loader was AMC's number two priority in 1995—second only to acquisition of the C-17 Globemaster III (Prechtel, 1995).

Table 2.
War Reserve Material Stock Levels (Wingreen, 1995)

Loader	Authorized	Assigned	WRM Levels[1]
40K	362	283	69%
25K	723	685	90%
WBEL	264	131	25%

[1] WRM assets as a percentage of assigned versus authorized

Surprisingly, there has been little analysis of the impact that MHE prepositioning has on the success of a contingency operation. Intuitively, it makes sense that the more equipment there is prepositioned in theater, the less will have to be deployed when hostilities begin. However, the actual impact of prepositioning is difficult to measure in quantitative terms. Most would agree however, that the age and poor condition of our MHE fleet greatly increase the cost of executing the air mobility mission. Several after action reports and studies conducted following the Gulf War touched on the consequences of not having adequate levels of prepositioned equipment available (Blackwell, 1991:35). By most accounts, the Gulf War tested the value of strategic mobility more than any other conflict in our nation's history, and perhaps the history of warfare (Menarchik,1993:xiv). In the five years since that conflict, America has grown even more dependent on strategic mobility.

In the book, Powerlift—Getting to Desert Storm, Colonel Douglas Menarchik reports on results of an extensive study of the logistics effort that made victory possible, and chronicles the performance of each element of the mobility triad. As he points out, airlift, sealift, and prepositioning each had well-publicized difficulties, but early in the build-up it was airlift that had to overcome some of the most daunting challenges.

> The cargo handling equipment was old and sparse, and getting their repair parts had low priority...Cargo handling equipment affected the amount of airlift into Dhahran that in turn affected the ability to build up rapidly...At one point in Desert Shield, strategy equated to cargo handling equipment! (Menarchik, 1995:75)

Many of these challenges arose due to problems with the airlift infrastructure, but by anyone's standard, the infrastructure available in Saudi Arabia was very good. In the early phases of the deployment however, there were only two primary offload bases: Dhahran and Riyadh. The sheer volume of commercial, fighter, and cargo aircraft traffic at these two locations created severe congestion problems.

In the meantime, a massive flow of aircraft began leaving the CONUS from as many as 110 to 115 different airfields (Menarchik,1993:74). Before long the flow of equipment and personnel from the CONUS exceeded the throughput capacity of these two aerial ports. The length of delays in-theater quickly reached critical proportions.

Fortunately, the United States had adequate quantities of war material, including limited numbers of MHE, prepositioned on ships located close to the Persian Gulf. However, an overall shortage of prepositioned MHE and qualified cargo specialists in-theater adversely affected the deployment (Menarchik, 1993:74). The situation was further compounded by the theater commander's decision to deploy combat forces ahead of the logistics infrastructure. That decision, combined with a lack of sufficient prepositioned MHE, resulted in near gridlock at these Aerial Ports of Debarkation (APOD). At one point, the congestion and lack of equipment was so acute that wide body aircraft had to be offloaded manually (Menarchik, 1993:75). Had there been open hostilities, the situation would have likely deteriorated into total chaos.

The lessons learned from Operation Desert Shield, Restore Hope, and others have far reaching implications for USTRANSCOM. The ability to support such far-reaching deployments will involve a significant investment in support equipment, especially MHE. Such an investment should go hand in hand with current defense strategy, and address mobility issues from a systems approach. Only then will the DTS be completely responsive to the needs of the war-fighting CINC.

Summary

The deployment problems experienced in the Gulf War can be attributed to the fact that the Cold War force structure was lacking in strategic mobility capability. In fairness, the strategic mobility system was unprepared for such a contingency. Since that time, our national military strategy has added greater emphasis to the strategic mobility aspects of force structure (Blackwell, 1991:51). The chief lesson to be learned is that strategic mobility does not happen by mistake, nor can it be assumed away.

The two MRC strategy is founded on some optimistic assumptions. For example, is it reasonable to assume that current strategic airlifters will provide enough lift capacity to meet the requirements of one MRC, followed 45 days later by a geographically separate MRC? The acquisition of 120 C-17s will bring the million ton miles level up to MRS recommendations, but that alone will not ensure success. The ability to airlift outsized and oversized cargo will prove to be the key to success in such a strategy. But how much of this capacity will be dedicated to repositioning MHE? Given the age and condition of MHE, it would appear that a significant amount of capacity will be needed, and in effect lost, to repositioning these assets. Once the MHE arrives in the theater, there will be serious questions as to its ability to sustain a long-term airlift operation.

Only through careful planning, long term financial commitment, and reasonable strategic assumptions can the DOD begin to address some of the challenges facing our strategic mobility forces. Chapter III focuses on analyzing the cost of purchasing additional MHE and compares it to the peacetime cost of repositioning these assets from one location to another.

III. Analysis

Introduction

The primary focus of this chapter is comparing the monetary cost associated with repositioning MHE, by air from one location to another, to the cost of purchasing additional MHE to meet DOD requirements. Table 3 list the FY96 Special Assignment Airlift Mission (SAAM) flying hour rates (Kennedy, 1996). Air Mobility Command SAAM planners use these figures to determine the cost they charge various government agencies for using a particular airlift asset.

Table 3.
SAAM Flying Hour Rates - In FY96 Dollars (Kennedy,1996).

Aircraft	DOD Rate	U.S. Govt Rate[1]	MAR[2]	Contingency/Exercise
C-130	3,574	5,285	7,148	2,200
C-141	4,813	7,554	9,626	3,426
C-17	5,694	7,183	11,388	4,663
C-5	11,341	15,974	22,682	9,243
KC-135	3,645	6,887	7,290	2,950
KC-10	7,316	11,482	14,632	5,208

[1] U.S. Government, non-DOD. Provided for comparison purposes only.
[2] Minimum Activity Rate. Equal to twice the flying hour rate for each period exceeding 24 hours.

The dollar figures listed above include the use of the aircraft for the scheduled mission itinerary, fuel, use of the airlift infrastructure, and aircrew cost (Kennedy, 1996). The rates in Table 3 apply whether the aircraft is flown at its maximum cargo capacity or empty. A typical airlift mission consist of three segments (Kennedy, 1996):

Positioning Leg - Involves moving the aircraft from a particular location to where the user's airlift requirement exists. The customer pays the full SAAM rate for this mission segment, regardless of the amount of cargo carried.

Active Leg - This mission segment involves the physical transport of the customer's cargo, and may or may not include air refueling.

Depositioning Leg - If the mission terminates at a location other than the aircraft's home station, or a station where the aircraft can not assume another mission, the customer must pay for the return flight. In this case, the customer pays the full SAAM rate.

To ensure the aircraft is flown daily, whenever the aircraft is not utilized for more than a 24 hour period, the user pays an amount equal to twice the flying hour rate. In the case of the C-17, this amount would be $11,388 for each 24 hour period. Scheduled crew rests, if less than 24 hours, are exempt from this Minimum Activity Rate (MAR).

Special Assignment Airlift Mission costs are determined using an historical database that maintains the average annual flight time between selected points of departure and selected points of arrival. To protect the customer from unexpected flight diversions or other system delays, AMC will not charge a customer for the cost of returning a mission to its scheduled itinerary (Kennedy,1996). Additionally, when an organization buys a SAAM, it has a great deal of control over the itinerary, subject to system constraints. These features give a customer a great deal of flexibility in meeting their own unique mission requirements.

Determining the Cost of Repositioning

As an instrument of National Security Strategy, airlift provides unmatched speed and flexibility. However, it is by far the most expensive mode available within the DTS.

Using the information in Table 3 and a hypothetical airlift requirement, the cost of repositioning MHE from one location to another can be determined.

> <u>Mission Profile</u>: Move a 40K loader from Pope AFB, North Carolina to Dhahran AB, Saudi Arabia using a C-17 from Charleston AFB. The mission is planned with a crew rest at Ramstein AB, Germany. From Dhahran the aircraft will return to Charleston AFB via Torrejon AB, Spain. See Figure 3.

This mission profile was selected because each location will likely play a significant role in a future Middle East contingency.

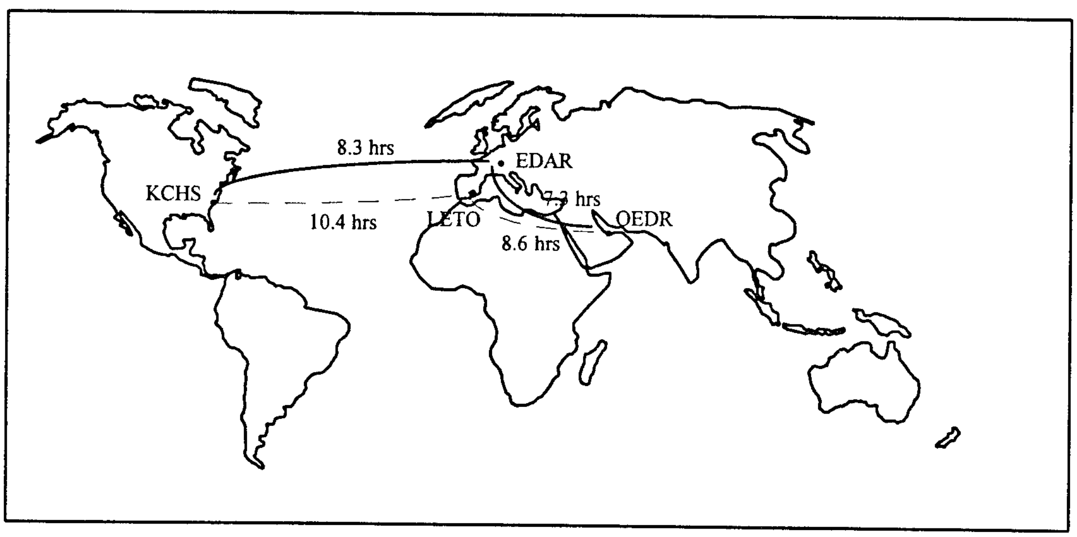

Figure 3. Hypothetical Mission Profile.

The data listed in Table 4 has been calculated using information extracted from Table 3 and Headquarters AMC SAAM historical flying times. The C-17 was selected for illustration purposes; however, a C-141 could be used to perform this mission at a lower total cost. The C-5 is also an option, but that aircraft would be the most costly choice.

Meeting the customer's airlift requirements at the lowest overall costs is AMC's chief priority (Kennedy,1995). With that in mind, AMC usually does not give the user the choice of aircraft. That decision is based on factors such as airlift requirements, availability of aircraft, and aircraft utilization.

Table 4.
Cost of a Hypothetical Airlift Mission.

Mission Segment[1]	**Departure Location**	**Arrival Location**	**Flight Time**[2]	**Segment Cost**[3]
Positioning	Charleston AFB	Pope AFB	1.2	6,832.80
Active	Pope AFB	Ramstein AB	8.3	47,260.20
Active	Ramstein AB	Dhahran AB	7.3	41,566.20
Depositioning	Dhahran AB	Torrejon AB	8.6	48,968.40
Depositioning	Torrejon AB	Charleston AFB	10.4	59,217.60
		Total Airlift Cost		**203,845.20**

1 See page 17 for a description of the different mission segments.
2 Annual average flight time over that particular route segment, excluding taxi time (Arino, 1996).
3 Segment cost = average flight time x SAAM flying hour rate ($5,694).

The total airlift cost of $203,845 is a significant amount of money to spend to transport a single 40K loader from the CONUS to a theater location. Usually however, the user would plan to utilize all available cargo capacity, because this would lower the per unit cost of transportation. In this example a C-17 was used to provide the airlift, which has a peacetime Allowable Cabin Load (ACL) of 45 short tons (s/t) (AFP 10-1401, 1996:14). A 40K loader weighs approximately 23 s/t, which gives the user an additional 22 s/t of cargo capacity to use at their discretion, however there is no discount for using less than the aircraft's total cargo capacity (Kennedy, 1996).

One common characteristic of the 40K, 25K, and WBEL is they are each very heavy, which takes up a great deal of the aircraft's weight capacity more so than its cubic capacity. If a C-141 is used in-lieu of a C-17, the total transportation cost would decrease. However, the 40K would be all that the aircraft could carry, which results in higher per unit cost. Table 5 lists the weights of various types of MHE and their suitability for transport aboard different aircraft.

Table 5.
MHE Weight and Transportability Data (AFP 10-1401, 1996:14; Wingreen 1995).

Aircraft Planning Data			MHE Planning Data[1]				
Aircraft Type	Pallet Positions	Cargo ACL (s/t)[2]	25K	40K	60K	WBEL	Percentage of ACL[3]
C-130	6	10	x	---	---	x	N/A
C-141	13	22.5	x	x	x	x	97%
C-17	18	45	x	x	x	x	48%
C-5	36	65	x	x	x	x	33%

[1] Weights for the 25K, 40K, 60K, and WBEL are 10.5 s/t, 22 s/t, 32.5 s/t, and 13 s/t respectively.
[2] Cargo ACL used for planning purposes only. Actual aircraft payload will vary as a function of departure airfield restrictions, flight duration, and other aircraft limitations.
[3] Percentage shown is calculated based on the weight of a 40K loader.
x - denotes transportability on that particular aircraft.

As aircraft payload increases, its unrefueled range decreases. One method of overcoming this limitation is through air refueling. However, if this option is not available, the only other alternative is to fly the aircraft to an intermediate location for refueling before proceeding on the remainder of the mission. What ever refueling mode is selected, the flying hour rates in Table 3 do not change (Kennedy, 1996). For example, the flying hour cost of a C-17 is still $5,694, even if a KC-10 or KC-135 is used to refuel it. Clearly the use of air refueling is more costly than ground refueling, however the tanker's flying hour costs are not passed on to the customer—AMC absorbs it. The reason? Air refueling gives AMC aircrews the opportunity to meet some of their air refueling training requirements on an operational mission, which is considered to be in the best interests of the command, regardless of the cost differential (Kennedy, 1996).

The use of airlift to transport such equipment in peacetime is very expensive, but is to a degree the cost of maintaining readiness. The aircraft need to be flown if aircrews are to receive training, and the only way to ensure a competent crew force is through training. Whether the aircraft is flying MHE or some other type of equipment is irrelevant. However, during a contingency, using limited airlift resources in such a manner can have a negative impact on our response capability.

Force Closure Estimate

In monetary terms, Table 3 shows that contingency airlift is less expensive than peacetime airlift. However, during a contingency, airlift assumes a greater expense when you consider its impact on force closure. The reader should note that these cost are difficult to quantify. The estimate calculated below is a heuristic approach to understanding the value of prepositioning MHE, as well as the cost associated with diverting airlift assets in a contingency environment. More sophisticated models that determine finite closure estimates, under varying system constraints, are also available. However, for a broad understanding of the costs tradeoffs associated with deployment estimates, the airlift capability formulas are useful.

In the simplest of terms, force closure refers to the amount of time it takes to deliver, also known as close, a deployment force to a particular location (AFP 76-2, 1987:6). Once the decision to deploy troops has been made, the theater CINC will need to know when combat forces will arrive. To calculate force closure time, joint and component planners can use the airlift capabilities formula to determine broad-based airlift and tanker closure estimates (AFP 10-1401, 1996:2). See Figure 4.

Time to Arrival

$$= \frac{\text{(active route flying time)} + \text{(active route ground time)}}{24}$$

Cycle Time

= round trip flying time (RTFT) + round trip ground time (RTGT)

Closure

$$= \frac{\text{(airlift requirement)} \times \text{(RTFT)}}{\text{(average payload)} \times \text{(number of aircraft)} \times \text{(USE rate)}}$$

Fleet Capability (short tons delivered to the theater per day)

$$= \frac{\text{(average payload)} \times \text{(number of aircraft)} \times \text{(USE rate)}}{\text{(RTFT)}}$$

Where:

$$\textbf{RTFT} = \frac{\text{distance 1}}{\text{block speed 1}} + \frac{\text{distance 2}}{\text{block speed 2}}$$

RTGT = ground time 1 + ground time 2 + ground time 3 + ...

USE rate = wartime objective surge UTE rates (recommended).

$$\textbf{Number of Cargo Missions Required} = \frac{\text{cargo requirement}}{\text{average payload}}$$

Figure 4. Airlift Capability Formulas (AFP 10-1401, 1996:10).

Force closure estimates are calculated using deployment information provided by the Joint Staff. The Joint Staff does not define specific aircraft capabilities such as average payload, block speed, and Utilization Rate (UTE). Instead, the staff apportions aircraft to the theater commander based on the type of contingency. Using the formulas in Figure 4, a force closure estimate can be calculated using a hypothetical aircraft apportionment (AFP 10-1401, 1996:10).

Application of the Airlift Capabilities Formula

To understand how the airlift capability formulas are applied, assume elements of the 82nd Airborne Division will deploy with 4,500 s/t of equipment to Dhahran AB using an apportionment of 20 C-17s and the same mission profile discussed earlier.

It should be noted by the reader that a contingency deployment of the 82nd Airborne Division would represent a significant foreign policy decision on the part of the United States, and depending on the circumstances, would likely be given priority over combat support units. The contingency deployment priority is identified in the Time Phased Force Deployment Listing (TPFDL), which USTRANSCOM uses to coordinate the transportation requirements of each unit (Morrow, 1995). Furthermore, this scenario is developed strictly using the C-17. In reality, AMC could use any one of its strategic airlifters to meet this requirement, or a combination thereof. The intent of this example however, is to demonstrate how removing a single aircraft from the airlift flow can increase the closure time estimate. Using the data in Table 6 and the formulas listed in Figure 4, a force closure estimate can be calculated.

Table 6.
Extracted Data (AFP 10-1401,1996:14).

Type Aircraft	**# of Aircraft**	**Block Speed (knots)**	**Avg Payload[1] (s/t)**		**UTE Rate[2] (hours/acft/day)**	
			ACL	Average	Surge	Sustained
C-17	20	429	45	40	15.15	13.9

[1] In a large operation, units should expect to achieve the average payload due to loads that reach volume constraints prior to weight constraints.
[2] Utilization Rate (UTE) is used in-place of USE rate. Surge rate is used to determine closure estimate.

Solution

Performing the calculations in Figure 4 leads to a closure estimate of 12.8 days. This figure represents the time required to deploy 4,500 s/t of equipment to Dhahran AB, Saudi Arabia using 20 C-17s. There are two key assumptions that have been applied to the airlift capability formula. First, planners are basing their estimates on having all apportioned aircraft immediately available to deploy forces (AMOC, 1995:29). Given the C-17 is not fully operational, combined with the extensive maintenance requirements of other strategic airlifters, makes this assumption difficult to achieve. Second, the 12.8 day estimate is based on unrestricted traffic flow at onload, enroute, or offload locations (AMOC, 1995). At best, this assumption is difficult to achieve in the CONUS, but experience tells us that rarely is unrestricted flow a possibility at forward deployed locations. Material Handling Equipment constraints during Operation Desert Shield accounted for significant aerial port congestion. Current mean time between failure (MTBF) for the 40K loader is approximately 8 to 10 hours, which would require that multiple loaders, with spares, be available to meet theater offload requirements (Wingreen, 1996). In a worst case scenario, a theater aerial port could lose several of its MHE assets to mechanical failure, which may require additional loaders to be flown into that location. In previous force closure calculations, using 20 C-17s resulted in a closure estimate of 12.8 days. If AMC needed to remove one of the aircraft from the 82nd Airborne deployment to reposition two 40K loaders from the CONUS to the theater offload location, the closure estimate increased to 13.5 days, for a net increase of 17 hours. Although it is difficult to quantify this estimate in terms of combat capability, at some point a delay of this duration will impact the theater commander, and in a combat scenario, a 17 hour delay in force closure could be the difference between success or failure.

The Cost of Modernization

The use of antiquated MHE has a negative affect on AMC's ability to efficiently onload or offload equipment at key aerial ports, which in turn jeopardizes our ability to stop a potential aggressor. Purchasing the new 60K will be expensive, with a per unit cost of $1 million, including spares (Wingreen, 1996). However, $200,000 to fly a C-17 from the CONUS to the Middle East is also a substantial amount of money. At current airlift costs, repeating that process more than four times equates to an additional 60K loader.

With our limited airlift capacity in seemingly constant demand, it does not make economic sense to continue with the peacetime practice of repositioning MHE.

Additionally, if the strain on the peacetime airlift system is so great as to warrant continuing this practice, what capability can AMC expect to get out of the airlift system during a contingency? Clearly, Air Mobility Command and the rest of the DOD would gain greater benefit by increasing the number of loaders prepositioned at various locations worldwide.

The large loader replacement contract calls for buying 318 units, with a delivery rate of three a month starting February 1997. By the year 1999, as older 40K loaders begin to retire in large numbers, deliveries of the 60K will increase to six a month. For the money, AMC and the DOD will finally have a loader that meets the needs of not only military airlifters, but commercial wide body aircraft as well.

Initial Operational Test and Evaluation (IOT&E) of the 60K is scheduled for June 1996, which is concurrent with the first deliveries of the loader. Fielding a combat support system prior to completion of operational testing is unusual, and indicates the degree of concern AMC has for the condition of its MHE fleet (Wingreen, 1996). The reliability data presented in Figure 5 forms the basis for this concern among AMC contingency planners.

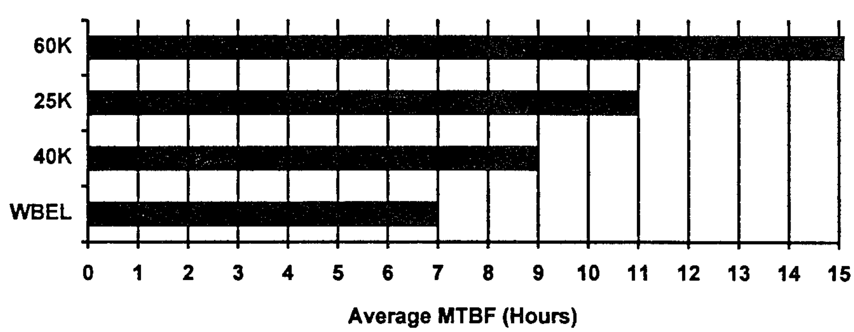

Figure 5. Materials Handling Equipment Reliability Estimates (Wingreen, 1996).

Among the advantages expected from the 60K loader over current systems are increased capability and reliability. For example, the fact that the 60K is capable of reaching the elevated cargo decks of commercial wide body aircraft means the command is no longer limited to those airfields that had operational WBELs on hand. According to the MRS, the CRAF will be needed to airlift as much as 35 percent of the 50 million ton miles per day cargo requirement (Port, 1996). It would be difficult to effectively achieve that level of participation using the chronically unreliable WBEL, particularly when it is assigned at 49 percent of command authorizations (See Table 1). Without sufficient quantities of WBELs, the number of airfields available to the CRAF is effectively reduced, which creates the potential for prolonging the deployment of combat forces and their equipment. The arrival of the 60K, combined with available WBELs, would increase the number of airfields available to CRAF carriers, thereby increasing the delivery rate of personnel and equipment into the theater.

Reliability improvements in the 60K are also expected to substantially improve cargo operations throughout the airlift system. Although official MTBF estimates for the 60K will not be available until completion of the IOT&E, it is expected to be significantly more reliable than current equipment. In general, the enhanced capability provided by the 60K is key to improving aerial port operations.

According to AMC, the 60K is projected to be the equivalent of 1.13 40K loaders (Wingreen, 1996). Table 7 describes what this relationship means in terms of equipment authorizations. Eventually, the 60K will completely replace the aging 40K. Based on the projected delivery schedule, the 60K should be completely fielded by the year 2004. By the year 1999, the command should have received the first 156 loaders, exceeding the peacetime operating stock (POS) requirement of 143 40Ks (Appendix C). The key issue for AMC is one of how to use the newly arriving 60K loaders. Specifically, should the 60K be used to meet peacetime aerial port requirements, or should it be used to fill shortfalls in WRM at locations that are below authorization levels?

Table 7.
MHE Authorizations Expressed in 60K Equivalent Units.

Type Loader	Number Authorized[1]	Percent Assigned[2]	Needed to Meet Authorizations[3]	Remaining Capability
25K[4]	723	95	19	299
40K	362	78	71	228
WBEL	265	49	135	93

[1] Authorizations extracted from Appendix A. 1.96 x 318.
[2] Values extracted from Table 1.
[3] Value calculated using: 723 (1 - .95) = 36, and 36/1.96 = 19. Remaining calculations similar.
[4] WBEL = 60K and 1.13 40K = 60K.

The data listed in Table 7 is valid only under the assumption that AMC will receive all 318 units at one time. Obviously, that will not be the case. Therefore, any decision to preposition the 60K in a WRM status would strictly be short term, primarily because the numbers of 60Ks will not be sufficient to simultaneously replace the 40K and fill existing MHE shortfalls. Additionally, it is cost prohibitive to continue to reposition older MHE throughout the airlift system while state-of-the-art equipment sits unused in a reserve capacity. As pointed out earlier, eventually it becomes cheaper to buy additional loaders and field them where needed, instead of continuing with the repositioning. These two reasons effectively eliminate the option of using the 60K exclusively to fill existing WRM shortfalls.

The other option available to AMC is to forward deploy the 60K at select enroute locations. Augmenting existing loaders with the new 60K should significantly reduce the frequency of repositioning MHE between locations. Unfortunately, MHE repositioning will be hard to avoid as long as antiquated loaders form the bulk of our capability. Air Mobility Command needs a new loader now, not later. Improving the peacetime health of the air mobility system should be our first priority, and positioning the 60K at each of our enroute locations first would provide a much needed boost to our capability.

Air Mobility Command's contingency airlift system is essentially a reflection of the peacetime system. The only difference being the operations tempo (OPSTEMPO) is much higher in a contingency environment. Therefore, increasing our peacetime capability will also increase our combat capability.

<u>Summary</u>

The short term health of the airlift system is still perilous. Acquisition of the 60K is a step in the right direction, but it will be several years before all 318 loaders are fielded. Even when the 60K is completed operational, AMC will continue to have significant shortages of WBELs. Over the long term, enhancements in capability and reliability in the 60K promise to increase AMC's responsiveness, but until that time, AMC will have no choice but to continue with the inefficient practice of airlifting MHE between locations. Using airlift for such purposes is expensive, and determining such cost often comes down to color of money issues.

To a degree, this practice is unavoidable, because there is no way to predict with 100 percent certainty where the next contingency or natural disaster will occur. Additionally, it is fiscally impossible to buy enough MHE to preposition at every potential crises spot around the world, especially when each 60K cost the taxpayer nearly $1 million. In fact, the two MRC strategy acknowledges that certain types of support equipment, like MHE, will have to be transported between conflicts. However, the decisions made regarding MHE positioning can not be made at the expense of peacetime support requirements. Currently, AMC intends to field the 60K loader at enroute support locations prior to fulfilling the requirements of other off-line locations (Wingreen, 1996). For the immediate future, this plan is certainly the most cost effective, because it is illogical to habitually transport MHE between locations in a peacetime environment.

During the Gulf War, the United States was given the luxury of time and world class facilities to deploy combat troops and equipment. In the future, the U.S. may not be so lucky. The next conflict may stretch our force projection capability to the limit. In such a situation, every aircraft, and for that matter, every mission is critical. Prepositioning combat or support equipment has a force multiplying affect, and directly influences our responsiveness. The ultimate goal being to release airlift aircraft to support their primary mission—deploying combat forces to the theater.

IV. Recommendations and Conclusion

Overview

It is a commonly used expression that logistics wins wars. Unfortunately, logistics is often overlooked in favor of more glamorous aspects of our defense capability. With the end of the Cold War came the emergence of a new National Military Strategy, and the realization that America needed armed forces that could respond to potential crisis' anywhere in the world, and do so quickly. Today, the DOD has developed a keen awareness of the value of strategic mobility, and how that capability affects our national security interests. In fact, airlift, sealift, and prepositioning have come to represent the cornerstones of American military capability.

The Cost of Airlift

The cost of maintaining a strategic mobility capability is high, with airlift representing the most expensive mode. The aircraft that make up our strategic airlift fleet represent the most visible element of our airlift capability, but equally important is the complex infrastructure of support equipment and facilities, without which the airlift system could not function. The limited availability of reliable MHE throughout the airlift system has been a growing source of difficulty for AMC. Simple stated, there is barely enough operationally reliable MHE to meet the peacetime operating requirements of the airlift system. To keep up with demand, AMC reluctantly uses airlift to move these assets from one location to another, usually at great expense to the command. But how is this expense described or assigned? As was pointed out earlier in the paper, using FY96 SAAM flying hour rates, the cost of a peacetime airlift mission from the CONUS to the Middle East was determined to be $203,000. That dollar figure is somewhat misleading, because in reality, it cost much less than that to operate the aircraft. However, assigning cost to activities and services is a very complicated and time consuming process.

The Air Force assesses airlift charges on a fully allocated cost basis, which means the customer is charged for all the cost associated with operating the aircraft throughout the airlift system. This makes it very difficult to accurately determine, in monetary terms, the actual cost associated with repositioning MHE from one location to another. While such a costing method creates overly inflated prices, it is at least an attempt to account for the various services provided within the military. Unfortunately, until another, more realistic costing method is developed, it will be difficult to fully understand the true cost involved in repositioning MHE between locations. Activity Based Costing is one alternative to the current costing system, however it exceeds the scope of this paper. Nevertheless, such a topic would make for excellent follow on research, and would greatly benefit the DOD.

The Effect of Repositioning on Force Closure

The impact of repositioning was accurately illustrated through the application of the airlift capability formulas. There is no doubt that removing an aircraft from a contingency deployment does have a negative affect on force closure estimates, and that in itself, should be enough to justify the expense of upgrading the MHE fleet. As Desert Storm pointed out, at some point in a large scale deployment the use of antiquated MHE will result in delay. That in turn will lead to the need to reposition mission capable loaders from a given location to the theater APOD. The only way to alleviate this problem is to phase out older equipment, and replace it with new, state of the art loaders. In other words, what AMC needs is more capable MHE, not necessarily greater numbers of it. On the other hand, what the command absolutely does not need is to rebuild existing loaders. A rebuilt loader would do little in terms of improving capability, because it would still not be able to access the elevated cargo decks of commercial wide body aircraft.

Given the uncertainty of today's budget environment, it is very unlikely that funding will increase to the point that would allow for buying enough loaders to meet two nearly simultaneous MRC's without repositioning. Additionally, not everyone in AMC agrees that the problem with MHE is strictly based on quantity available (Wingreen, 1996). Even if one takes this position, there is still serious problems with the reliability of current loaders. If funding were available and AMC were to buy greater numbers of loaders, many of them would sit idle at locations that did not have enough activity to justify their purchase. Instead, AMC should focus primarily on improving the reliability and capability of next generation loaders, like the 60K, and continually validate the mixture of assets assigned as peacetime operating stock (POS) or War Reserve Material

(WRM). Of course, once the correct mix of loaders is determined, equal attention must be paid to the decision regarding placement of these assets.

Prepositioning will be key to the success of any large scale operation, especially one that is heavily dependent on airlift. Materials Handling Equipment is one such asset that lends itself to high levels of prepositioning, as long as the equipment is maintained and exercised on a regularly scheduled basis. Considering the potential impact insufficient MHE has on our force projection capability, next generation loaders should be engineered with this requirement in mind. At the time of this writing, AMC was considering proposals for a new generation of high lift 25K loaders that will replace existing 25K loaders. It will be a highly transportable loader designed to meet support requirements of all airlift aircraft, commercial and military, and greatly simplify the support requirements of the airlift system—exactly the kind of flexibility the DOD needs.

Summary

Over the last six years, AMC has maintained an unrelenting operations tempo that has substantially accelerated the retirement of the C-141 and severely strained the entire air mobility system. Older support systems like MHE have long reached the end of their designed life expectancy, and have become increasingly unreliable. The AMC staff has committed a great deal of time and money to managing these assets, yet the system will not be completely healthy until all outdated loaders are replaced with more reliable systems.

Acquisition of the 60K has been awaited with much anticipation, and should give the command a much needed boost in capability. The proposal for a new high lift 25K is also a much-needed step toward complete MHE modernization, but again that system, if developed, will not be available for several years. In the interim, AMC will have to continue to do the best it can with available resources. As the 60K becomes available, it should be immediately put into use at key aerial ports throughout the enroute system. The poor condition of existing loaders makes this the only logical choice. This is not to say that prepositioning is not important, because our ability to plan and position resources close to potential crisis spots will greatly influence our response credibility. However, the command cannot afford to reduce day-to-day efficiency at the expense of preparing for the next major conflict. Given that the peacetime airlift system is essentially a reflection of the contingency airlift system, an increase in the efficiency in the former can be expected lead to improvements in the latter.

Materials Handling Equipment is indeed the Achilles' heel of the airlift system; without it America would have enormous difficulty projecting combat forces abroad. Air Mobility Command has taken an aggressive position regarding support equipment modernization, and the long term outlook for MHE is improving. The world's most sophisticated combat force is of little value as an instrument of National policy without the mobility forces and infrastructure necessary to transport them. Therefore, continually improving the airlift system will be the key to providing Global Reach for America.

Appendix A: List of Acronyms

AB	Air Base
ACL	Allowable Cabin Load
AFP	Air Force Pamphlet
AFRES	Air Force Reserve
AMC	Air Mobility Command
AMMP	Air Mobility Master Plan
AMOC	Air Mobility Operations Course
AMWC	Air Mobility Warfare Center
CINC	Commander In Chief
CINCTRANS	Commander In Chief United States Transportation Commander
CONUS	Continental United States
CRAF	Civil Reserve Air Fleet
DTS	Defense Transportation System
IOT&E	Initial Operational Test and Evaluation
JCS	Joint Chiefs of Staff
MHE	Materials Handling Equipment
MOOTW	Military Operations Other Than War
MTMD	Million Ton Miles Day
MRC	Major Regional Conflict
MRS BURU	Mobility Requirements Study Bottom-Up Review
MTBF	Mean Time Between Failure
NAF	Numbered Air Force
NM	Nautical Miles
NMS	National Military Strategy
OPSTEMPO	Operations Tempo
RTFT	Round Trip Flying Time
RTGT	Round Trip Ground Time
SAAM	Special Assignment Airlift Mission
s/t	Short Tons
TPFDL	Time Phased Force Deployment Listing
USTRANSCOM	United States Transportation Command
UTE	Utilization Rate
WBEL	Wide Body Elevator Loader
WRM	War Reserve Material

Appendix B: K Loader Capability (AMCPAM 36-1, 1995:49)

Type Loader	Capability
25K	- Self propelled cargo transportation platform. - Can lift and transport 3 pallets up to a maximum cargo weight of 25,000 pounds. - Deck may be raised, lowered, tilted forward or aft permitting alignment with aircraft floors. - Transportable on the C-130, C-141, C-17, and C-5.
40K	- Offers increased capacity over 25K loaders, but are not designed to be routinely transported. - Not transportable on the C-130, poses difficulties when loaded on a C-141, and requires special considerations when airlifted on a C-5. - Can lift and transport married pallets or up to five single pallets weighing as much as 40,000 pounds.
WBEL	- The only loader in the inventory capable of loading or unloading wide body aircraft. - Transportable on the C-130, C-141, C-17, and C-5. - Must be disassembled prior to shipment, and require at least one 25K and one 6K forklift at both the onload and offload sites. - Cannot be used to load or unload C-130, C-141, C17 or C-5 aircraft.
60K	- Planned replacement for the 40K loader. - The most versatile of all K loaders. - Can be used to service all military and civilian aircraft. - Transportable on the C-141, C-17, and C-5. - Has the ability to lift and transport up to six pallets or 60,000 pounds.

Appendix C: MHE Worldwide Prepositioning Locations*

Location	25K		40K		WBEL[1]	
	POS[2]	WRM[3]	POS	WRM	POS	WRM
A.C. Thompson/Jackson	1	0	0	0	0	0
Abu Dhabi IAP	0	3	0	0	0	1
Adak AB AK	1	0	0	0	0	0
Al Dhafra	0	3	0	0	0	1
Al Kharj	0	7	0	2	0	3
Al Kharj	0	11	0	3	0	5
Alameda NAS CA	0	2	0	0	0	0
Alconbury RAF UK	2	0	0	0	0	0
Altus AFB OK	4	0	5	0	0	0
Andersen AFB GU	2	0	2	2	2	0
Andoya Norway	2	0	0	0	0	0
Andrews AFB MD	3	0	1	0	1	0
Andros Island	1	0	0	0	0	0
Antiqua	1	0	0	0	0	0
Araxos Greece	1	0	0	0	0	0
Ascension Island	1	0	0	0	0	0
Aviano AB IT	2	1	1	2	1	0
Bahrain	0	6	0	0	0	3
Barbers PT NAS	0	1	0	0	0	0
Barksdale AFB LA	2	9	0	4	2	3
Bateen	0	1	0	0	0	0
Beale AFB CA	1	2	0	0	0	0
Beuafort MCAS	0	3	0	0	0	1
Bergstrom AFB TX	0	1	0	0	0	0
Bermuda	1	0	0	0	0	0
Boise ID	0	1	0	0	0	0
Buraymi (Al Ain)	0	1	0	0	0	1
Cairo IAP	1	0	0	0	0	0
Cairo West	0	1	0	0	0	1
Cannon AFB NM	3	2	0	0	1	1
Cape Canaveral FL	0	0	1	0	1	0
Capodichino IT	2	0	1	0	0	0
Carswell TX	1	0	0	0	0	1
Castle AFB CA	0	1	0	0	0	1
Cecil Field NAS FL	0	1	0	0	0	0
Channel Island/Pt Mugue	2	0	0	0	0	1

* Data provided by HQ AMC/DOZE, 5 Nov 95
1 WBEL - Wide-body Elevator Loader
2 POS - Peacetime Operating Stock
3 WRM - War Reserve Material

Location	25K		40K		WBEL	
	POS	WRM	POS	WRM	POS	WRM
Charleston AFB SC	5	0	5	3	2	2
Charleston AMPF	12	0	0	0	4	0
Charlotte ANGB NC	1	0	0	0	0	0
Cherry Point MCAS	0	4	1	0	1	1
Cheyenne Apt WY	1	0	0	0	0	0
Chicago O'Hare IL	2	0	0	0	0	0
Chievres BEL	1	0	0	0	0	0
Chong JU KOR	0	4	0	1	0	0
Christchurch NZ	1	0	0	0	0	0
Coronet Aspen	2	0	0	0	0	0
Davis Monathan AFB AZ	2	4	1	0	0	3
Des Moines IA	0	1	0	0	0	0
Det 3 (HQ AFMC)	2	0	1	0	0	0
Det 42 (HQ AFMC)	0	0	1	0	0	0
Dhahran SA	2	24	2	24	1	7
Diego Garcia	2	0	1	0	1	0
Dobbins AFB GA	6	0	1	0	0	0
Dover AFB DE	2	2	13	4	3	2
Dover AMPF	12	0	0	0	4	0
Dyess AFB TX	4	0	0	0	0	0
Eareckson AFS AK	2	0	0	0	0	0
Edwards AFB CA	1	0	2	0	0	0
Eglin AFB FL	2	2	0	0	1	1
Eielson AFB AK	2	0	0	0	1	0
El Toro MCAS CA	1	5	0	2	1	3
Ellsworth AFB SD	2	0	0	0	0	0
Elmendorf AFB AK	4	0	4	0	2	0
England AFB LA	0	3	0	0	0	0
EW Reg Apt/Martinsburg	1	0	0	0	0	0
Fairchild AFB WA	2	0	0	0	0	0
Fairford RAF UK	1	0	0	0	0	0
Forbes AAF	0	3	0	0	0	2
Ft Campbell KY	3	9	0	3	1	4
Ft Wayne IN	0	1	0	0	0	1
Fujairah	0	1	0	0	0	1
Fukouka AB JA	1	0	0	0	0	0
Futenma MCAS	0	1	0	0	0	1
Gen Billy Mitchell Fld	1	0	0	0	0	0
Gioia De Colle IT	1	0	0	0	0	0

Location	25K		40K		WBEL	
	POS	WRM	POS	WRM	POS	WRM
Grand Forks AFB SD	2	0	0	0	0	1
Griffiss AFB NY	4	0	0	0	0	1
Grissom AFB IN	1	1	0	0	0	1
Guantanamo Bay Cuba	1	0	0	0	0	0
Gulfport MS	1	2	0	0	0	1
Hanscom Fld MA	1	0	0	0	0	0
Harrisburgh Intl PA	0	2	0	0	0	2
Hensley/Dallas TX	1	0	0	0	0	0
Hickam AFB HI	2	0	4	0	2	0
Hill AFB UT	2	4	0	3	1	1
Holloman AFB NM	2	3	1	1	1	1
Homestead AFB FL	1	1	0	0	0	1
Houston Intl TX	0	3	0	0	0	0
Howard AB PN	2	0	5	0	1	0
Hulman Fld IN	0	1	0	0	0	1
Hunter AAF GA	0	3	0	1	0	3
Hurghada Egypt	0	1	0	0	0	0
Hurlburt Fld FL	3	0	0	1	0	2
Incirlik AB TU	3	0	4	0	1	0
Istanbul TU	1	0	0	0	0	0
Iwakuni MCAS JA	1	9	1	4	1	0
Izmir AB TU	1	0	0	0	0	0
Jacksonville NAS FL	0	1	0	0	0	0
Jeddah IAP	0	4	0	0	0	1
Johnston Atoll	1	0	0	0	0	0
Jubail SA	0	11	0	4	0	5
K. I. Sawyer AFB MI	2	0	0	0	0	1
Kadena AB JA	4	2	4	8	3	0
Kanawha Apt WV	1	0	0	0	0	0
Kaneohe Bay MCAS	0	1	0	0	0	0
Karup Denmark	1	0	0	0	0	0
Keesler AFB MS	2	0	0	0	0	0
Keflavik NAS Iceland	2	0	0	0	0	0
Kelly AFB TX	2	0	2	0	1	0
Khamis Mushait SA	0	4	0	1	0	1
Kimhae AB KOR	2	20	0	25	0	5
King Abdul Aziz SA	0	7	0	0	0	2
King Fahd SA	0	7	0	2	0	4
King Faisal (Tabuk)	0	4	0	0	0	2

Location	25K		40K		WBEL	
	POS	WRM	POS	WRM	POS	WRM
King Faisal Naval	0	1	0	0	0	0
King Khalid IAP	0	3	0	0	0	1
King Khalid Military	0	1	0	0	0	1
Kirtland AFB NM	2	0	1	0	0	0
Kulis ANGB AK	1	0	0	0	0	0
Kunsan AB KOR	2	0	0	2	0	2
Kuwait IAP	0	2	0	0	0	0
Kwajalein	1	0	0	0	0	0
Kwang Ju AB KOR	0	6	0	2	0	2
Lackland AFB TX	3	0	1	0	0	0
Lajes Field Azores	2	0	2	0	1	0
Lakenheath RAF UK	3	0	0	0	0	0
Lambert IAP MO	0	1	0	0	0	0
Langley AFB VA	4	1	1	0	1	2
Laughlin AFB TX	0	2	0	0	0	1
Lawson AAF GA	0	3	0	2	0	3
Little Rock AFB AR	9	0	1	0	0	1
Luis Munoz Marin	0	1	0	0	0	1
Luke AFB AZ	2	0	0	0	1	0
MacDill AFB FL	1	2	0	0	0	1
Malmstrom AFB MO	1	0	0	0	0	0
Mansfield Apt OH	1	0	0	0	0	0
March AFB CA	2	4	1	4	2	1
Martin State Apt MD	1	0	0	0	0	0
Masirah	0	1	0	0	0	1
Mather AFB CA	0	1	0	0	0	1
Maxwell AFB AL	1	0	0	0	0	0
McChord AFB WA	5	0	3	5	2	2
McChord APMF	12	0	0	0	4	0
McClellan AFB CA	2	0	0	0	0	1
McConnell AFB KS	0	2	0	0	0	0
McEntire ANGB SC	0	3	0	0	0	1
McGee Tyson ANGB TN	0	1	0	0	0	0
McGuire AFB NJ	4	0	2	7	2	1
McGuire APMF	12	0	0	0	4	0
Memphis Intl TN	1	2	0	0	0	0
Michael AAF UT	0	1	0	0	0	1
Mildenhall RAF UK	2	0	2	0	2	0
Minhad	0	3	0	1	0	1
Minneapolis IAP MN	2	0	0	0	0	0

Location	25K		40K		WBEL	
	POS	WRM	POS	WRM	POS	WRM
Minot AFB ND	2	0	0	0	0	1
Misawa AB JA	2	1	0	1	1	0
Moffett NAS CA	0	1	0	0	0	1
Moody AFB GA	3	0	0	0	1	0
Moron AB SP	2	3	0	0	1	0
Mountain Home AFB ID	2	1	0	0	1	0
Muniz ANGB PR	0	1	0	0	0	1
Nashville Apt TN	2	0	0	0	0	0
Nellis AFB NV	4	0	1	0	1	0
New Orleans NAS LA	1	0	0	0	0	0
Niagara Falls Intl NY	1	0	0	0	0	0
Norfolk NAS VA	2	0	4	0	2	0
North Island NAS CA	0	2	0	0	0	1
Oceana NAS VA	0	0	3	0	0	0
Offutt AFB NE	2	0	0	0	0	1
Olmsted PA	0	1	0	0	0	0
Osan AB KOR	2	0	3	0	2	1
Patrick AFB FL	0	0	1	0	0	0
Peoria Intl IL	1	0	0	0	0	0
Peterson Fld CO	3	2	0	0	0	2
Phelp Collins ANGB	1	0	0	0	0	0
Phoenix/Sky Harbor AZ	0	1	0	0	0	0
Pisa AB IT	1	0	0	0	0	0
Pittsburgh, Greater PA	1	0	0	0	0	0
Plattsburgh AFB, NY	1	1	0	0	0	1
Pohang AB KOR	0	15	0	8	0	2
Pope AFB NC	21	0	6	1	3	3
Portland OR	1	0	0	0	0	0
Quonset PT RI	1	0	0	0	0	0
Ramstein AB GE	4	2	12	4	3	0
Reno Cannon Intl NV	0	1	0	0	0	0
Rhein Main AB GE	2	0	2	0	1	0
Richards Gebaur MO	1	0	0	0	0	0
Richmond NSW AS	1	0	0	0	0	0
Rickenbacker AFB OH	0	1	0	0	0	1
Riyadh SA	0	8	0	5	0	7
Robert Gray AAF TX	0	4	0	2	1	2
Robins AFB GA	1	1	0	5	0	2
Roosevelt RD PR	2	0	1	0	0	1
Rosecrans MEM	1	0	0	0	0	0
Rota NAS SP	2	0	2	0	2	0

Location	25K		40K		WBEL	
	POS	WRM	POS	WRM	POS	WRM
Salt Lake IAP UT	0	0	1	0	0	0
San Diego Intl CA	0	1	0	0	0	0
San Salvador El Salvador	1	0	0	0	0	0
Savannah GA	2	0	0	0	0	0
Schennectady Apt NY	1	0	0	0	0	0
Scott AFB IL	1	0	0	0	0	0
Seeb	0	1	0	0	0	1
Selfridge ANGB MI	1	0	0	0	0	0
Sembach AB GE	0	18	0	5	0	5
Seymour Johnson AFB NC	2	0	0	2	1	1
Shaikh Isa BH	0	5	0	0	0	2
Shaw AFB SC	4	0	0	0	1	1
Sheppard AFB TX	0	1	0	0	0	0
Sigonella AB IT	2	0	3	0	2	0
Singapore	1	0	0	0	1	0
Soto Cano HO	3	0	1	0	0	0
Souda Bay Crete	1	0	0	0	0	0
Spangdahlem AB GE	3	0	3	0	0	0
Standiford Fld KY	1	0	0	0	0	0
Stewart Fld NY	1	0	1	0	0	0
Suwon AB KOR	0	5	0	2	0	0
Taegu AB KOR	0	3	0	1	0	1
Taif SA	0	5	0	2	0	4
Tel Aviv IS	1	0	0	0	0	0
Thule AB Greenland	1	0	1	0	0	0
Thumrait	0	3	0	2	0	1
Tinker AFB OK	1	1	0	2	0	2
Torrejon AB SP	3	0	1	0	1	0
Travis AFB CA	2	2	10	48	2	6
Tyndall AFB FL	2	1	0	0	1	0
Vance AFB OK	0	1	0	0	0	0
Vandenburg AFB CA	0	0	1	0	0	0
Volk Fld/CMP Douglas	1	0	0	0	0	0
Wake Island	1	0	0	0	0	0
Westover AFB	2	0	1	0	0	0
Whiteman AFB MO	2	0	0	0	0	0
Will Rogers Apt OK	1	0	0	0	0	0
Willow Grove PA	1	0	0	0	0	0
Wilmington Greater DE	1	0	0	0	0	0
Woomera Austrailia	1	0	0	0	0	0
Wright Patterson AFB OH	2	0	2	1	0	4

Location	25K		40K		WBEL	
	POS	WRM	POS	WRM	POS	WRM
Wyoming Valley PA	1	0	0	0	0	0
Yechon AB KOR	0	4	0	2	0	0
Yokota AB JA	5	0	4	3	3	1
Youngstown OH	1	0	1	0	0	0
Yuma MCAS AZ	1	0	0	0	1	0
Total	373	350	143	219	96	169
	723		362		265	
	1350 (242 locations)					

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Vita

Captain Keith E. Nickles was born on 7 February 1963 in North Kingstown, Rhode Island. He graduated from Jacksonville Senior High School in 1981 and entered undergraduate studies at East Carolina University in Greenville, North Carolina. He graduated with a Bachelor of Arts degree in Mathematics in June 1985. He received his commission on 18 June 1985 through the Reserve Officer Training Corps program at East Carolina University.

After graduation from Undergraduate Pilot Training at Columbus AFB, he was assigned to McChord AFB where he served as a C-141B wing tactical mission planner and instructor aircraft commander. His second assignment was to Andrews AFB where he served as chief of wing standardization and evaluation for the C-21A. His third assignment was to Barksdale AFB where he flew the KC-10 and was chief of squadron scheduling and operations management. In August 1994, his unit was reassigned to McGuire AFB. In February 1995, he entered the School of Logistics and Acquisition Management, Air Force Institute of Technology as part of the Advanced Study of Air Mobility (ASAM) program. His follow-on assignment is to HQAF/XOOOC (Air Force Current Operations).

Permanent Address: 618 Shadowwood Drive
Jacksonville, NC 28540

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13. ABSTRACT *(Maximum 200 words)*

This research paper examines airlift system support issues, and in particular, issues concerning Materials Handling Equipment (MHE). Limitations of existing loaders have forced AMC to adopt the practice of using airlift to reposition MHE between theater locations. It is assumed that such a practice is costly to the command, both in terms of monetary expense and capability. Two issues relating to MHE will be examined in this paper; the cost of repositioning these assets, and the impact repositioning has on force closure. To meet system demands, AMC commits a significant amount of airlift to repositioning MHE. This practice is very costly in terms of time and money. Lost time in a two MRC scenario can be the difference between success or failure. Although difficult to quantify in terms of capability, this study suggests that in a contingency environment, transporting MHE between locations causes significant delays in force closure estimates. While the researcher offers no empirical data, it is intuitively evident that AMC will have difficulty meeting a two MRC airlift requirement using existing loaders, which seriously jeopardizes our ability to project power abroad. Modernizing the MHE fleet is key to meeting the requirements of a two MRC strategy.

14. SUBJECT TERMS
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The purpose of this questionnaire is to determine the potential for current and future applications of AFIT research. **Please return completed questionnaire** to: DEPARTMENT OF THE AIR FORCE, AFIT/LAC BLDG 641, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765 or e-mail to dvaughan@afit.af.mil or nwiviott@afit.af.mil. Your response is **important.** Thank you.

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4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

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